MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

ERT3046 – MACHINE VISION

(RE)

24 OCTOBER 2018
2.30 p.m – 4.30 p.m
(2 Hours)

INSTRUCTION TO STUDENT

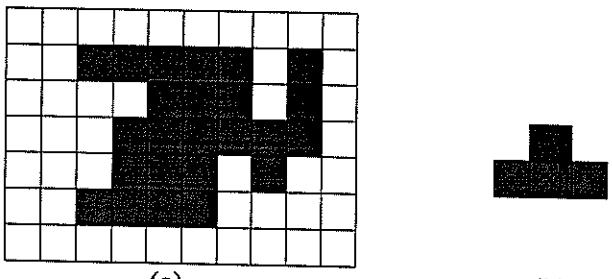
1. This Question Paper consists of 7 pages with 4 Questions only.
2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

QUESTION 1

a) A chemical company ABC recruits an Engineer to design an approach to detect when chemical bottles are not full. The bottles are moved along conveyor line with automatic filling and capping stations. A bottle is considered imperfectly filed when the level of liquid is below the midway point between the bottom of the neck and the shoulder of the bottle. The shoulder is defined as the region of the bottle where the sides and slanted portion of the bottle intersect. The bottles are moving, but the company has an imaging system that equipped with an illumination flash front end that can effectively stop motion, so the Engineer will be given sample image. Based on the following tasks, design solution to detect bottles that are not filled properly.

(i) Finding individual bottle [8 marks]
(ii) Finding the top of each bottle. [4 marks]

b) **Figure Q1(a)** shows an image where the objects are marked as dark grey shaded. Elaborate the result of morphological *OPENING* on **Figure Q1(a)** using the structuring element (S) as shown in **Figure Q1(b)**. [7 marks]



(a) **(b)**

Figure Q1: (a) Binary Image, (b) Structure Element (S)

c) In **Figure Q1(c)**, let $V=\{1\}$, show the shortest path between P and Q for:
(i) 4-adjencency. [2 marks]
(ii) 8-adjacency. [2 marks]
(iii) m-adjacency. [2 marks]

	0	0	0	0	1
	0	0	0	0	1
	0	1	1	1	0
	0	1	0	0	0
P	1	1	0	0	0

Q

Figure Q1(c)

Continued...

QUESTION 2

a) The hit-and-miss transform is a general binary morphological operation that can be used to look for particular patterns of foreground and background pixels in an image. For the Structure element (SE), it is slightly different from dilation and erosion.

(i) Describe the process on how to implement the hit-and-miss transform. [8 marks]

(ii) Given **Figure Q2(a)**, perform the hit-and-miss transform for this image with the interval as shown in **Figure Q2(b)**. [5 marks]

0	0	0	0	0	0
0	0	1	1	0	0
0	1	1	1	1	0
0	1	1	1	1	0
0	0	1	1	0	0
0	0	1	0	0	0

Figure Q2(a)

0	x	x
1	1	x
0	1	0

Figure Q2(b)

b) (i) A quad tree is considered an extension of pyramids for binary image. Describe the process of quad tree. [6 marks]

(ii) Given **Figure Q2(c)**, perform the process of quad tree. [6 marks]

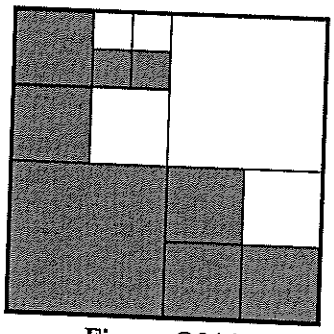


Figure Q2(c)

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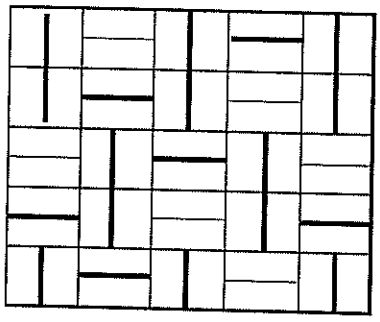
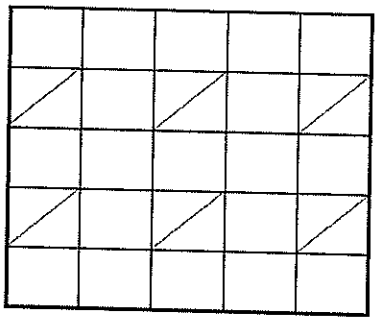
QUESTION 3

a) Since edge detection is a simple-to-apply feature detection scheme, it is natural to try to use an edge detector as the first step in texture analysis. Consider a region of N pixels. Suppose that a gradient-based edge detector is applied to this region producing two outputs for each pixel. Analyze the texture features for **Figure Q3(a)**.

(i) Edgeness per unit area for pattern A and pattern B. [3 marks]
(ii) Gradient-magnitude histogram for pattern A and pattern B. [3 marks]
(iii) Gradient-direction for pattern A and pattern B. [2 marks]



Pattern A



Pattern B

Figure Q3(a)

b) The gray level co-occurrence matrix $P[i,j]$ is defined by first specifying a displacement vector $d = [dx, dy]$ and counting all pairs of pixels separated by d having gray levels i and j based on the image shown in **Figure Q3(b)**.

(i) Create the co-occurrence matrix for displacement $d = [1,1]$. [4 marks]
(ii) Create the co-occurrence matrix for displacement $d = [-1,1]$. [4 marks]
(iii) Analyze the energy and homogeneity levels for the co-occurrence matrix obtained for displacement $d = [-1,1]$. [4 marks]

2	1	2	0
0	2	1	1
0	1	2	2
1	2	2	0

Figure Q3(b)

c) Moment analysis is also a popular technique for describing shapes. In general, a moment of order (p+q) can be manipulated to be invariant to scaling, translation and rotation. **Figure Q3(c)** shows the contour of an object as indicated by the dark pixels. Find the normalized central moment η_{11} for the object as shown in **Figure Q3(c)** (treat the dark gray pixel as 1). [5 marks]

Continued...

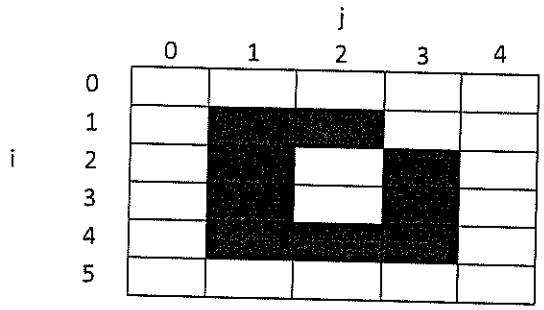


Figure Q3(c)

Continued . . .

QUESTION 4

a) There are four possibilities for the dynamic nature of the camera and world setup namely stationary camera, stationary object (SCSO), stationary camera, moving objects (SCMO), moving camera, stationary object (MCSO), and moving camera, moving objects (MCMO). For analyzing image sequences, different techniques are required in each of the above cases. Discuss the above four techniques [6 marks]

b) **Table Q4(b)** shows **Two (2)** classes (**Class X, and Y**) which are classified through their extracted features represented by points in 2-dimensional space.

(i) Evaluate to which **class M** is classified into by using 5-nearest neighbour class. (*Use Euclidean distance as the distance metric)* [4 marks]

(ii) Evaluate and plot the graph for the **Two (2)** classes for feature extraction. [3 marks]

Table Q4(b)

Class X

Axis	x-axis	y-axis
point1	0.63	0.3
point2	0.55	0.4
point3	0.5	0.33
point4	0.72	0.45
point5	0.68	0.35
Point6	0.45	0.32

Class Y

Axis	x-axis	y-axis
point1	0.31	0.34
point2	0.44	0.28
point3	0.35	0.13
point4	0.48	0.29
point5	0.51	0.3
Point6	0.62	0.12

Class M

Axis	x-axis	y-axis
point	0.55	0.34

c) **Figure Q4(c)** shows the pattern segmentation for two images which are hand segmentation of image A and the automatic segmentation of image A. For hand segmentation, it has three regions namely m1, m2 and m3. For the automatic segmentation, it has three regions namely k1, k2 and k3.

(i) Evaluate the over-detection error for automatic segmentation. [4 marks]

(ii) Evaluate the under-detection error for automatic segmentation. [4 marks]

(iii) Evaluate the average over-detection error and average under-detection for the three regions of automatic segmentation. [4 marks]

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m1	m1	m1	m1	m1	m1
m2	m2	m2	m1	m1	m1
m2	m2	m2	m3	m3	m3
m2	m2	m2	m3	m3	m3
m2	m2	m2	m3	m3	m3
m2	m2	m2	m3	m3	m3

m1 mark as region 1, m2 mark as region 2, m3 marks as region 3 for hand segmentation of Image A

k2	k2	k2	k2	k2	k2
k1	k2	k1	k2	k2	k3
k1	k1	k1	k3	k3	k3
k1	k1	k1	k1	k3	k3
k1	k1	k1	k1	k3	k3
k1	k1	k1	k1	k3	k3

k2 mark as region 2, k1 marks as region 1, k3 marks as region 3 for auto segmentation for Image A

Figure Q4(c)

End of Paper